Cement MILL SECTION of

Concrete

Vol. 25 JULY, 1924 No. 1

Synchronous Motors for Cement Mill Drive

By G. E. Cassidy

Industrial Engineering Dept., General Electric Co.

From a paper presented at the Spring meeting of the Portland Cement Association, Los Angeles, Cal., May, 1924.

The cement mill falls in that relatively small class of mills where the heat available from the process of manufacture makes the question of whether power should be purchased or whether it should be generated at the mill, deserving of careful consideration for every installation. It is not the purpose here to debate this question, and it, therefore, suffices to say that irrespective of from which source the mill power is derived, it can be more economically obtained and utilized in the form of alternating current power than direct current power. The chief advantage derived from the use of direct current, in such a plant as a cement mill, is the easy and economical manner in which accurate speed variation can be obtained by means of the direct current motor. With the exception of the kiln coal and raw material feeds, and possibly one or two other minor power requirements, there is no variable speed machinery in the cement mill that cannot be adequately taken care of by alternating current motors. Therefore, we may say without appreciable error, that in the modern cement mill alternating current is the only form in which the primary power supply should be obtained and utilized.

Limited then to the use of alternating current power, the cement mill engineer has at his command

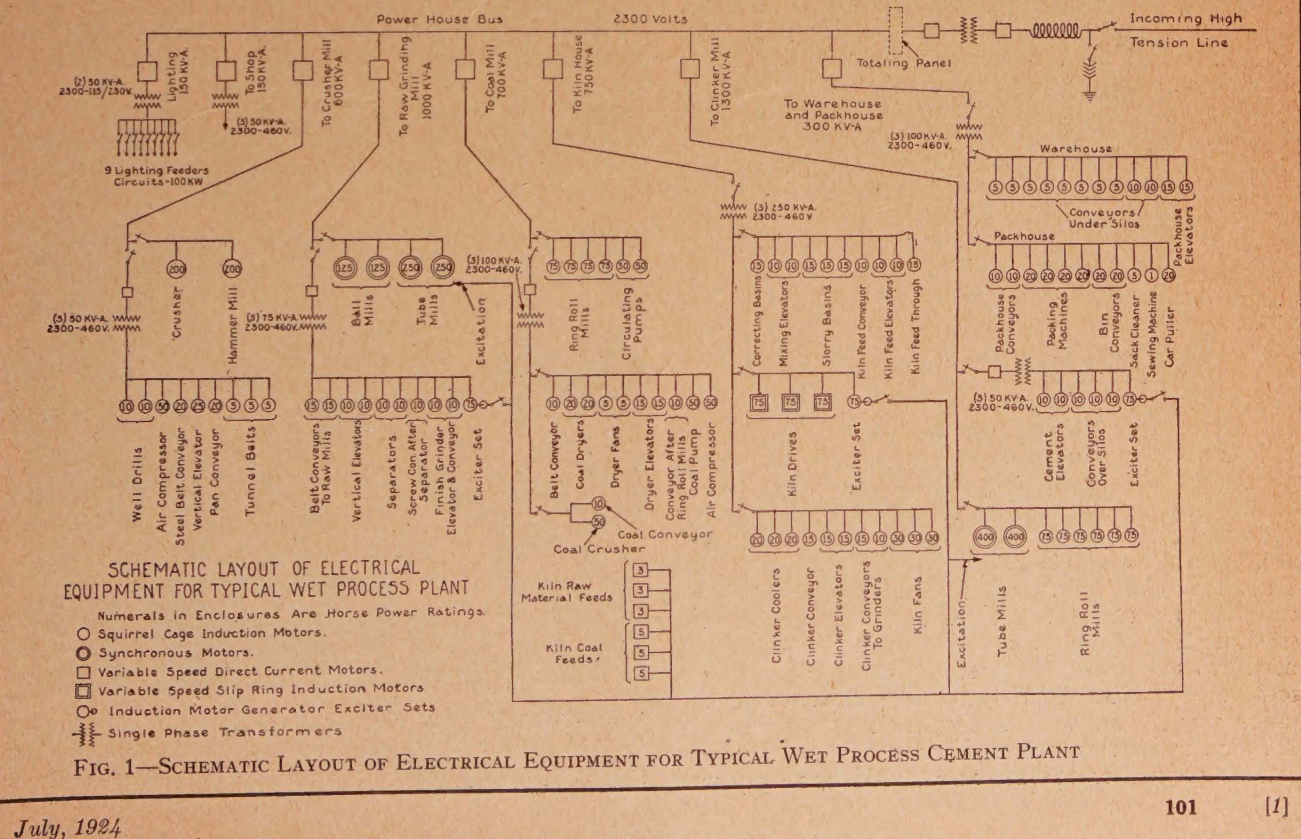


Fig. 1—Schematic Layout of Electrical Equipment for Typical Wet Process Cement Plant

for the major portion of his machinery, but three types of motors, the squirrel cage induction motor, the wound rotor induction motor, and the synchronous motor. Each of these motors possesses particular advantages, and as there is a legitimate use for all of them in the modern cement plant, let us consider briefly their salient characteristics.

From a mechanical standpoint, there is no question but that the squirrel cage induction motor, with its absence of sliding contacts and its simply constructed rotating member, is one of the most simple and sturdy of all electrical driving equipments. From an electrical standpoint, this motor, also, has the outstanding advantage of simplicity, very little auxiliary apparatus being required for its operation, and little attendance being necessary after the machine is once started, as no skill of the operator can change its operating characteristics. Therefore, if the squirrel cage induction motor were not deficient or lacking in certain characteristics it would be the ideal type of motor for all applications throughout the mill.

However, the squirrel cage induction motor is a constant speed machine which precludes its use where speed variation is necessary. It is, also, a motor that should not be applied to machinery requiring high starting torque. In starting up the usual cement mill loads, the squirrel cage induction motor imposes relatively severe line disturbances on the power system of the mill, so that in the large size motors these disturbances may be sufficiently appreciable to further exclude its use. To overcome these difficulties, we resort to the wound rotor induction motor, and if there were not still further desirable characteristics lacking in both these types of units, we would limit our main driving machinery for the entire mill to the squirrel cage and wound rotor induction motors. As a matter of fact, this is what was actually done until a few years ago, when cement engineers became appreciative of the fact that the characteristics of their mill power systems could be greatly improved by the addition of a third type of motor, the synchronous motor.

The synchronous motor possesses three distinct advantages which greatly outweigh its chief disadvantage, that of greater complicity, and make it a valuable adjunct to the propelling equipment of the mill. The power factor of the synchronous motor is within the control of the operator, and can be made unity, lagging or leading at will by the manipulation of the field rheostat. The synchronous motor has higher efficiency which is particularly advantageous where large units are employed. The synchronous motor lends itself to most economical operation where slow speed machinery requiring relatively large driving units is involved.

These three advantages, then, answer the question why synchronous motors should be used. The last advantage also points out the answer to the question where they should be used. Let us consider briefly each of these advantages.

Maximum power output within a minimum of installed generating and distributing capacity is obtained when the power factor is unity. If power is purchased, a bonus on rates can usually be obtained if the power factor of the mill is maintained within certain limits. If power is generated at the mill, the nearer the power factor is maintained to unity, the less will be the investment in electrical equipment. This effect of power factor is illustrated in Fig. 2. If induction motors only were installed in the power system shown in Fig. 1, and if these motors operated at an average power factor of 78%, the total generating capacity of the station would have to be equivalent to approximately 5650 h.p. in heating value. However, if synchronous motors designed to operate at an 80% leading power factor are installed at the points indicated, the station generating capacity would have to be equivalent to only 4550 h.p. in heating value or, to use electrical terminology, the kilovolt ampere rating of the generators in the second case would be 20% less than in the first. Although there are other considerations entering into the question of power factor, this illustration points out the main reason why power factor improvement is an important advantage, and, therefore, why synchronous motors should be used from this standpoint. In this connection it should be noted that, because the power factor of the synchronous motor is under the control of the operator, it is quite possible to obtain a poorer power factor with the synchronous motor than is inherent in the induction

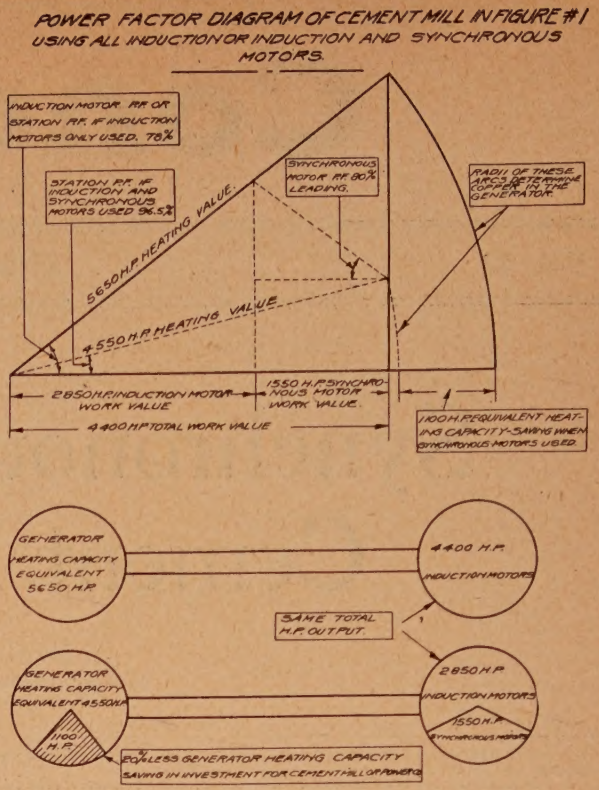

POWER FACTOR DIAGRAM OF CEMENT MILL IN FIGURE #1
USING ALL INDUCTION OR INDUCTION AND SYNCHRONOUS MOTORS.
INDUCTION MOTOR P.F. OR STATION P.F. IF INDUCTION MOTORS ONLY USED. 78%
STATION P.F. IF INDUCTION AND SYNCHRONOUS MOTORS USED 96.5%
SYNCHRONOUS MOTOR P.F. 80% LEADING.
RADII OF THESE ARCS DETERMINE COPPER IN THE GENERATOR.
5650 H.P. HEATING VALUE.
4550 H.P. HEATING VALUE
2850 H.P. INDUCTION MOTOR WORK VALUE
1550 H.P. SYNCHRONOUS MOTOR WORK VALUE.
4400 H.P. TOTAL WORK VALUE
1100 H.P. EQUIVALENT HEATING CAPACITY-SAVING WHEN SYNCHRONOUS MOTORS USED.
GENERATOR HEATING CAPACITY EQUIVALENT 5650 H.P.
4400 H.P. INDUCTION MOTORS
SAME TOTAL H.P. OUTPUT.
GENERATOR HEATING CAPACITY EQUIVALENT 4550 H.P.
1100 H.P.
2850 H.P. INDUCTION MOTORS
1550 H.P. SYNCHRONOUS MOTORS
20% LESS GENERATOR HEATING CAPACITY SAVING IN INVESTMENT FOR CEMENT MILL OR POWER CO.

Fig. 2—Power Factor Diagram of Cement Mill in Fig. 1, Using all Induction or Induction and Synchronous Motors

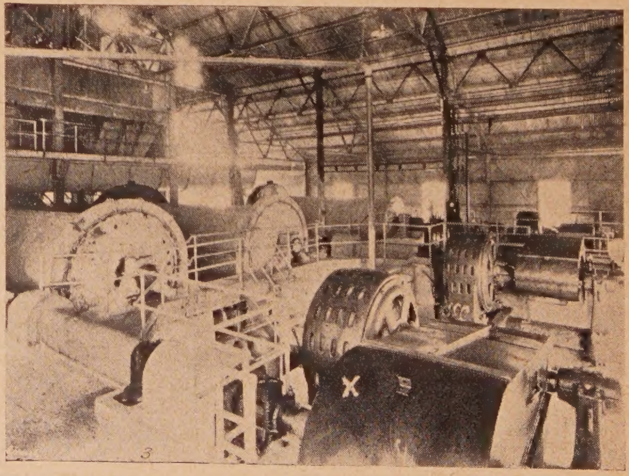
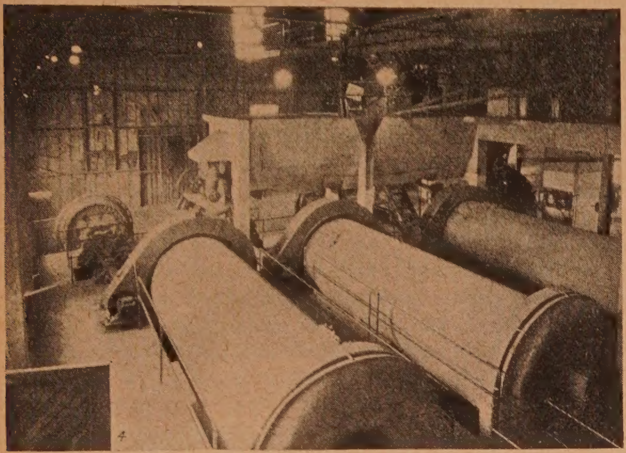
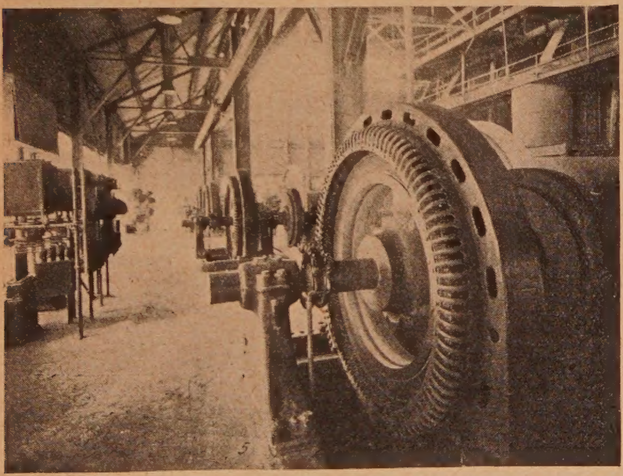


Fig. 3—500-H.P., 450-R.P.M., 550-Volt Wound Rotor Induction Motors Driving Tube Mills Through Silent Chains. This Illustrates Good Practice Prior to the Introduction of Synchronous Motors

motor. Responsible synchronous motor operators are, therefore, essential.

The advantage of efficiency needs no comment. The higher the efficiency, the greater, of course, the economy in power consumption. It is of interest to note here that differences of several percent are often found in synchronous motor specifications that are submitted by different manufacturers in their synchronous motor proposals. Tabulated efficiencies vary appreciably, depending upon how the motor losses are measured, what losses are included, and on what motor power factor the efficiencies are based. The motor efficiencies must necessarily be arrived at on the same basis if they are to be comparable, and although most electrical manufacturers do obtain their synchronous motor efficiencies in accordance with a definite set of rules, occasionally a set of specifications are found which do not conform to these rules. Therefore, since the cement manufacturer, as far as efficiency is concerned, in reality desires to obtain a motor that will take the least electrical input for a given horsepower output, it is well for him to examine the basis on which efficiency guarantees that look exceptionally high are made up.





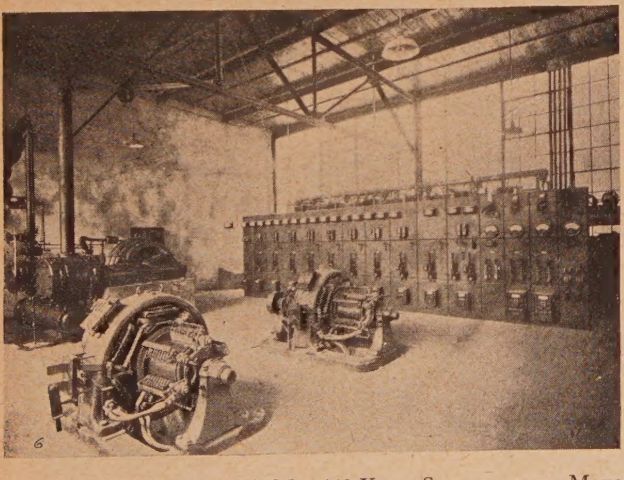


Fig. 4—250-H.P., 200-R.P.M., 440-Volt Synchronous Motors Driving Tube Mills Through Mechanical Clutches. Mechanical Clutches Were Used When Synchronous Motors Were First Introduced

Fig. 5—500-H.P., 180-R.P.M., 2200-Volt Synchronous Motors Driving Tube Mills Through Magnetic Clutches. This Shows Good Modern Practice Where Magnetic Clutches Are Employed

Fig. 6—A Modern Cement Mill Power Room. Note the Self-Starting Synchronous Motor Direct Connected to the Air Compressor

The third consideration, that of economical operation at low speed, carries with it all the advantages well known to be derived from direct connection with the elimination of speed-reducing equipment, belts, chains, and the like. Occasionally, an engineer will call for a high speed synchronous motor to be used with a belt or chain drive. In so doing, he immediately loses one of the big advantages derived from the use of synchronous motors.

As already stated, the third consideration points to where the synchronous motor should be used. Synchronous motors will make possible the most economical original investment and the lowest subsequent operating cost of the electrical equipment of the mill if their application is limited to the inherently slow speed machinery, or that machinery requiring relatively large units of power. This class of machinery includes tube mills, compartment mills, ball mills, kominuters, Bradley-Hercules mills, hammer mills, air compressors, and the like. It is well to remember that, as a general rule, approximately 50% of the power consumed in the mill is consumed in the grinding machinery, so that if synchronous motors operating at an 80% leading power factor are applied to these machines, and induction motors operating at a 75% or 80% lagging power factor are used in the remainder of the mill, the resulting power factor of the mill will be very near unity. It should also be remembered that a considerably greater gain in economy is obtained in raising the mill power factor from 80% to 90% than in raising it from 90% to unity.

Turning to the last question, that of how synchronous motors should be applied, an important characteristic of this type of motor immediately comes to the fore. If the synchronous motor is designed for maximum economy during operation, it cannot also be designed to develop sufficient torque during the starting period to start the usual cement mill loads. As economy of operation is essential, it is, therefore, necessary to design the motor to start without load, and then resort to some mechanical means of applying the load to the motor after it has been brought to speed and synchronized.

In the early days of synchronous motor applications in cement mills, synchronous motors of standard construction were employed, and mill loads were put on the motors by means of mechanically operated clutches. These clutches were never entirely satisfactory, however, especially where they were called upon to take up heavy loads and transmit comparatively large amounts of power. The electrical or magnetic clutch was, therefore, introduced at an early date, and as a necessary adjunct to the synchronous motor in cement mill practice, played an important part for many years. It was generally recognized, however, that even the magnetic clutch did not present an ideal link between the synchronous motor and its driven machine. Appreciative of this fact, the General Electric Co., a few years ago, undertook a detailed study of the general question of applying loads requiring high starting torque to synchronous motors. During the investigation of this question, it soon became apparent that the magnetic clutch possessed certain inherent characteristics that could not be economically overcome, and it was, therefore, decided to eliminate the magnetic clutch entirely and resort to a new type of motor construction. As a result, the super-synchronous motor was developed and placed on the market, and although this motor has been available for but a comparatively short time, the very gratifying reception that has been accorded the numerous installations made up to the present time seems to indicate that this departure from routine practice was well justified.

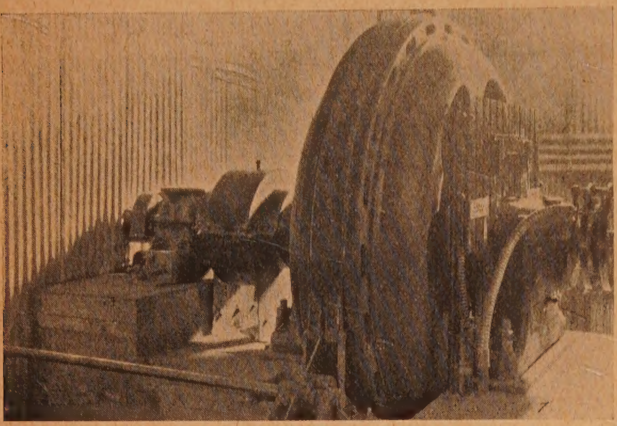
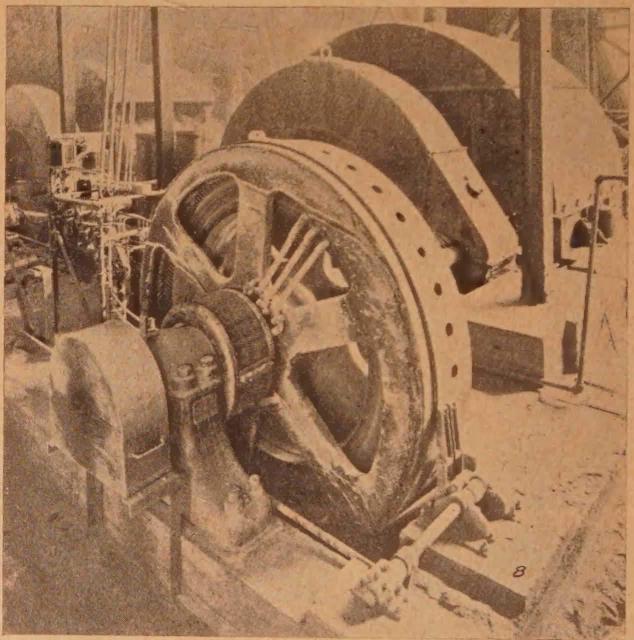


Fig. 7—500-H.P., 187½-R.P.M., 2200-Volt Super-Synchronous Motor Driving Tube Mill. This Shows the First Super-Synchronous Motor to be Installed

The construction and operation of the combination synchronous motor and clutch are well understood and, therefore, need no comment here. The construction of the super-synchronous motor is clearly indicated in the accompanying illustrations. The electrical construction and essential dimensions of this motor are identical with those of the usual synchronous motor of the same rating. The special features are found entirely in the mechanical construction of the unit. The motor armature is suspended so that it can rotate during the starting period, suspension being accomplished by hollow journal extensions on the end shields, which are carried by bearings at the inner ends of the motor standards. The periphery of the motor frame is machined for a braking surface, and is fitted with a standard brake band, lever and quadrant of mine hoist and cableway practice. The current is taken to the armature windings through rings which are normally stationary. During starting, the brake is released, the armature is energized and comes up to induction motor speed. The field is then energized and the armature comes to synchronous speed. Then, by applying the brake, the armature is slowed down, which results in the starting and speeding up of the field and attached load. The field accelerates to synchronous speed proportionately as the armature is brought to rest. As soon as the armature becomes stationary, the brake is locked and the motor continues to operate as a normal synchronous motor.

The electrical characteristics of each type of motor are identical. They are both designed to start without load, and, therefore, are designed for the highest efficiencies and economies. The electrical characteristics of the motors themselves, then, can be forgotten.

The predominating feature of the super-synchronous motor is the physical operating characteristics of the brake in placing the load on the motor. The magnetic clutch must necessarily have a very small clearance between its faces. In a clutch for a 500-h.p. motor, this is approximately one-eighth of an inch. Therefore, the distance through which the one face of the clutch has to move in taking up its load is so small that smooth acceleration cannot be expected. On top of this, the rate at which the clutch is brought together is influenced by the number of resistance steps in the clutch control circuit and by the inductive effect of the clutch excitation coil. It is not feasible to use very many resistance steps in the control circuit, with the result that the operator has very limited control of the clutch between the full off and full on positions. It is, therefore, impossible to prevent the load from being "grabbed up" with a resulting undesirable, rapid acceleration. On the other hand, the full off to the full on positions of the super-synchronous motor brake are regulated over the large arc through which the brake lever travels. The load can, therefore, be applied to the motor at any rate desired by the operator. In driving a tube mill, for example, a torque of about 150% normal torque is required during the first fraction of a revolution of the mill, after which the torque rapidly drops to about 80% normal, and then gradually builds up again to normal as full speed is approached. If a super-synchronous motor is used to drive such a mill, the brake can be tightened until the mill begins to revolve and then be loosened to comply with the



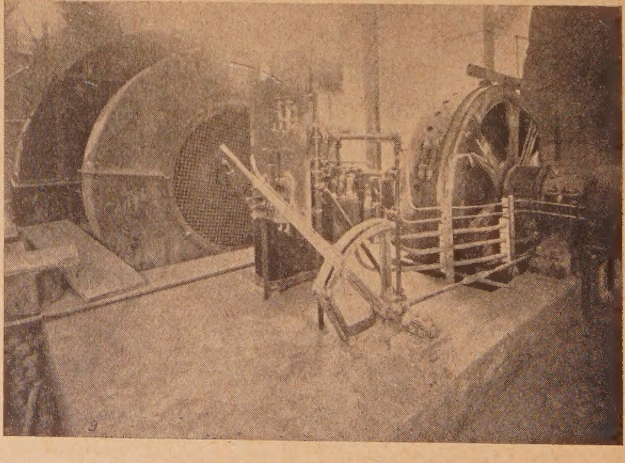


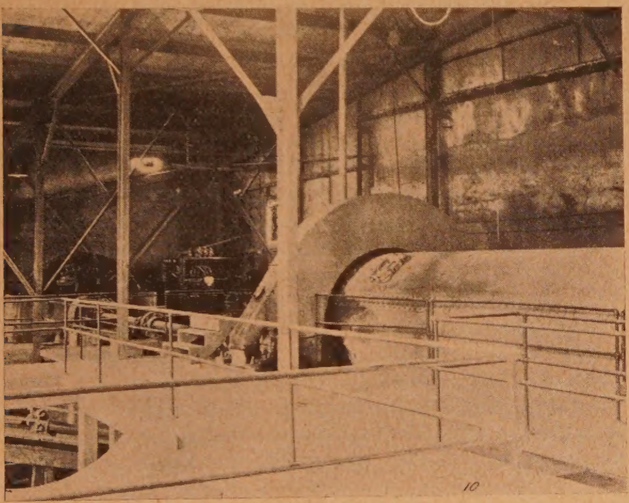
Fig. 8—400-H.P., 156½-R.P.M., 400-Volt Super-Synchronous Motor Driving A Kominuter

Fig. 9—Another View of the 400-H.P. Super-Synchronous Kominuter Motor

torque required. This results in a minimum of power being drawn from the electrical system, only such power as is absolutely necessary to start the mill being required. Such control with a clutch is impossible.

This ease of manipulation not only puts complete control in the hands of the operator, allowing him to accelerate the mill at any rate he desires, or accurately turn the mill to any position required, but it also has other very important advantages. If a mill, for example, is driven by a combination 500-h.p. motor and clutch, and the power for the motor is furnished by a 100 kw. turbine, nearly a half of the capacity of the turbine is thrown with exceptional rapidity upon it when the motor is started. This results in an undesirable jar of the electrical and mechanical system all the way along. With the ease of manipulation offered by the brake, however, these disturbances are reduced to a minimum. This not only means that the turbine is subjected to greatly reduced stresses, but also that the gear, pinion, shafting, and bearings of the mill itself are stressed to a much lesser degree. All of these features tend toward the minimum of breakage and maintenance expense.

The elimination of the clutch reduces the replacement of starting and running friction surfaces to a minimum. For a 500-h.p. motor of average cement mill rating, the clutch has an approximate area of 1975 sq. in., with a mean radius of approximately 24 in., while for this same motor, the brake has an area of approximately 1790 sq. in., with a mean radius of approximately 44½ in. On this basis, in transmitting 500 h.p. the clutch or brake must hold 9160 lb. ft., or the clutch must exert a pull of 4580 lb., as compared with 2480 lb. for brake. Assuming material with the same friction properties is used for both clutch and brake, the pressure on the wearing surface must be 172% greater for the clutch than for the brake. Therefore, it is evident that the clutch will be subject to considerably greater wear than the brake. Furthermore, when the motor is running, the brake is not subjected to any slippage and, therefore, no wear occurs from this source; whereas the clutch, due to irregularities in alignment may be subjected to slight creepage which will increase the wear on the clutch. Assuming that the motor has a pull out torque of 250%, the clutch must be capable of holding maximum pull of 11,500 lb. as compared with 6150 lb. for the brake.



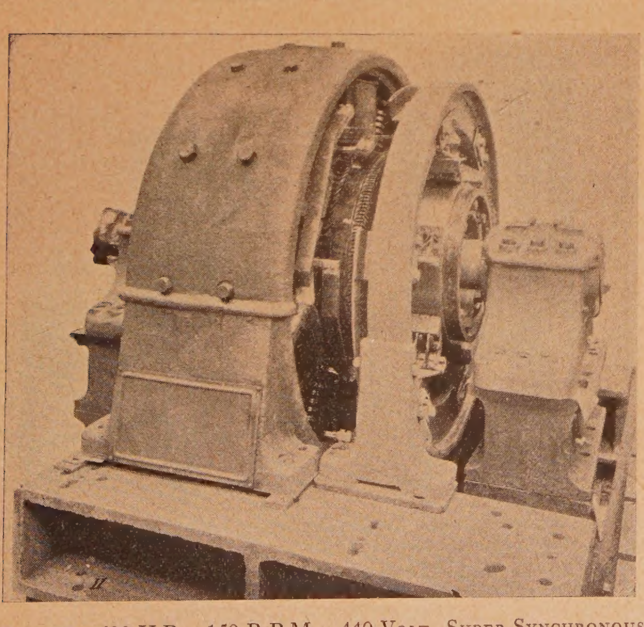


Fig. 10—600-H.P., 150-R.P.M., 440-Volt Super-Synchronous Motor Driving a Tube Mill

Fig. 11—Another View of the 600-H.P. Super-Synchronous Tube Mill Motor

The elimination of the clutch eliminates the excitation expense of the clutch. The clutch for the 500 h.p. motor referred to above requires approximately 1½ kw. for excitation. Basing a kilowatt year at a cost of from $75.00 to $125.00, this means an annual saving of from $115.00 to $185.00, or capitalized at 20%, is equivalent to an investment of from $575.00 to $925.00. Assuming that four of these motors are placed in the mill, and capitalizing the total saving as above, an equivalent saving in investment of from $2300.00 to $3700.00 results. Another way of looking at the matter is that the efficiencies of the motor are increased to the extent that the clutch excitation is eliminated.

The elimination of the clutch means the substitution of a normally stationary starting equipment for normally heavy running equipment. The clutch for a 500-h.p. motor weighs approximately 4800 lb., and that for a 650-h.p. motor 6000 lb. When we stop to consider this point, it is evident that these are pretty high values, for the stator frame of the 500-h.p. super-synchronous motor weighs only 3200 lb., and that for the 650-h.p. motor 5600 lb. When the clutch is used, this means that the bearings are subjected to continual wear while the motor is in operation, whereas with the super-synchronous motor, the bearings are subjected to wear only during the starting period.

The elimination of the clutch allows for the elimination of one bearing absolutely necessary when the clutch is used, thereby reducing the first cost and the maintenance charges. If the clutch is used, a bearing must be interposed to hold the non-rigid clutch in alignment. This bearing must be of sufficient size to support the weight of the clutch. Not only this bearing, but also the motor bearings are subjected to wear due to the clutch weight. If the clutch is not used, the outboard bearing is eliminated unless the line shaft is so long that a bearing seems to be desirable to keep the shaft in alignment. However, if such a bearing is necessary, it may be of minimum dimensions, as it merely must support a part of the weight of the shaft.

The elimination of the clutch, of course, eliminates the necessity of floor space required for the clutch. Whether or not this is an advantage to the cement manufacturer doubtless depends upon the machinery arrangements and perhaps also upon personal opinion. The elimination of the clutch, however, does save space, and it is an actual fact that this is a distinct advantage in some industries.

Another point that is deserving of consideration is

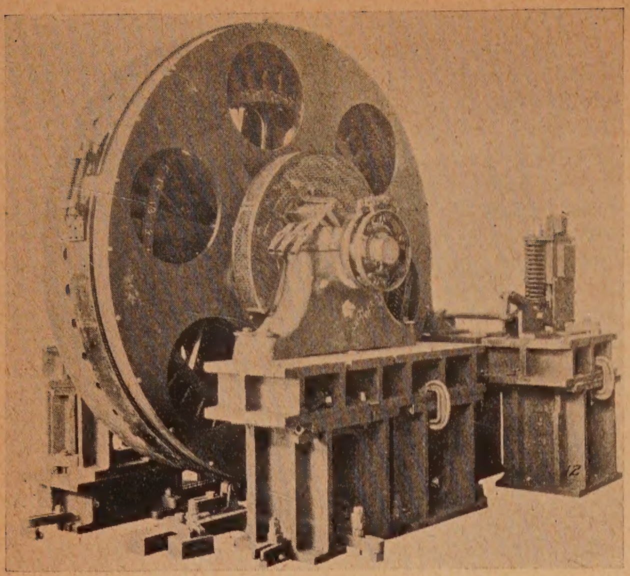


Fig. 12—600-H.P. Super-Synchronous Motor Set up for Shop Tests. Note the Solenoid Brake Mechanism

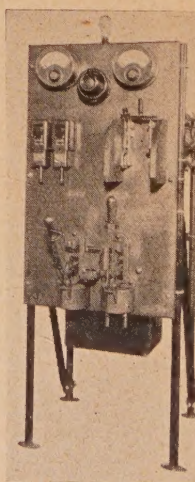
that of the heating of the clutching mediums for each type of motor. To obtain the maximum life of these mediums, heating should be kept to a minimum. With the brake, the heating surface is far less concentrated than it is with the clutch, so that as heat is generated it is more rapidly dissipated in the former than the latter. On top of this, however, the clutch does not only dissipate the heat generated by friction, but it must also continuously dissipate the 1½ kw. of excitation energy which is transformed entirely into heat within it.

In addition to the above advantage, it is desirable to cover brifly some points that have been raised from time to time as objections to the super-synchronous motor by men who have had occasion to study the unit. The statement has been made on several occasions in the past that the super-synchronous motor is not as accessible for internal repairs as the ordinary synchronous motor, which is usually designed so that the stator can be moved to one side of the rotor. This statement is entirely correct, and especially so when reference is made to the first super-synchronous motors to be built, as these motors did not include the later refinements of split bearings and split end shields. If extensive internal repairs have to be made to a super-synchronous motor, the field and armature without question have to be removed from the bearings and one of the end shields taken off. However, this objection is not as important as it might at first hand appear to be. It is not meant to infer by this that repairs do not have to be made on these synchronous motors, for such is not the case, but I must say that these repairs are very infrequent. I might add here that many synchronous motors of General Electric manufacture that were installed on the Pacific Coast back in 1900 are still running, and, in truth, bid well to continue to do so for several years to come. As a matter of fact, the cement industry has just gone through its induction motor stage. The small air gap characteristic of the induction motor makes it considerably more susceptible to internal damage than the synchronous motor with its relatively large air gap. Large induction motors, as they are generally built, really require that the machine be torn down if the armature or rotor has to be repaired. When these induction motors were in common use, the question of inaccessibility was not given important stress.

A question has been raised on a few occasions in regard to the pedestal bearings with which these motors are furnished, the claim being made that it is more difficult to install a motor with these pedestal bearings than one with a base. This claim is also true, but this motor can be furnished with its own base if such a construction is desired. However, although it is a little more difficult to properly install the pedestal bearings, nevertheless the pedestal bearing motor makes a much neater installation and gives no more trouble than the motor with its own base, after it has once been set up.

While on the subject of bearings, someone has raised the objection that a super-synchronous motor has four bearings, whereas the ordinary motor has only two, and, therefore, the super-synchronous motor naturally has more bearings to take care of. This also is quite true. Each pedestal contains two bearings, one of the usual construction for supporting the shaft, and the other of a similar construction for supporting the armature. But although there are two extra bearings to look after, these two bearings are used only during the starting period, and as the bearing pressures are maintained at a very low value, there is no real cause for worry from this standpoint. Furthermore, as has already been pointed out, the armatures of these machines weigh less than the corresponding clutches, and it naturally follows, therefore, that these armature bearings will not be subjected to the same wear as bearings designed to carry the clutches.

The question has come up from time to time regarding the operation of these super-synchronous motors as synchronous condensers without mechanical load. The claim has been made on one or two occasions that since the armature must continually rotate when the machine is operated as a condenser, this cannot be accomplished because of the bearing construction. In truth, this matter of synchronous condenser operation is really not a question of bearing design, but rather one of the desirability of operating these motors as synchronous condensers. If a unity power factor machine is installed, it will not deliver much more than a third of its capacity in corrective KVA when operating as a synchronous condenser. Therefore there would be little justification in designing the armature bearings of a unity power factor machine so that it



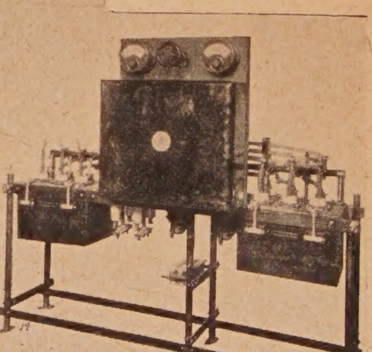


Fig. 13—Typical Synchronous or Super-Synchronous Motor Hand Control Panel

Fig. 14—(Right) High Voltage Automatic Control Unit for Synchronous or Super-Synchronous Motor. Illustration Shows One Contactor Tank Removed. This Type of Control is Particularly Adaptable to Cement Mill Service Because of its Dust-Tight Features

could operate continuously as a synchronous condenser. If a unit is rated at 80% power factor, about 70% of its capacity can be obtained in corrective KVA at no load. Therefore, there is more excuse for using an 80% power factor machine as a synchronous condenser. Nevertheless, if it is intended to use one of these motors as a synchronous condenser, the cement manufacturer should obtain a motor that will give him sufficient corrective KVA at no load to warrant the operation of one of these machines as a condenser. In obtaining such a machine, a larger investment will be necessary, and, therefore, as already stated, the whole question is not one of bearing design but rather of the desirability of operating one of these machines as a condenser. Those machines which have been installed and which were not intended to be used as condensers, have armature bearings which will not operate continuously day and night. For those machines that are intended to be used as synchronous condensers, these bearings have been designed for continuous operation. It is quite possible that in the future the armature bearings for all super-synchronous motors will be designed for continuous operations.

The control for these super-synchronous motors is exactly the same as that for the usual motor and clutch. Either hand control or automatic control can be furnished. As a general rule, automatic control is very desirable for use with synchronous motors, as it takes out of the hands of the operator the several operations that must be performed in bringing the motor up to speed and synchronizing it. The operator presses a push button station, and the several starting functions are automatically interlocked with a definite timing mechanism. When a synchronous motor and clutch is used, the load is applied to the motor by means of a knife switch or push button station. If a super-synchronous motor is used, it is usually applied by means of a hand brake. A super-synchronous motor can also be furnished, however, with an electrically operated brake, which consists primarily of a solenoid and dash-pot mechanism which permits of applying the brake at the desired rate, merely by pressing a push button station. This solenoid brake equipment is shown in illustrations included here.

The English Lime Industry

By Major C. W. D. Rowe

Managing Director Dunstable Lime Co., Ltd., Peterborough, England

> In introducing Major Rowe at the recent convention of the National Lime Association at White Sulphur Springs, where the following comparison of conditions was drawn by the English lime manufacturer, President Wood of the association referred to England as a land of milk and honey, across the Atlantic Ocean, on the face of this troubled world in which we live, and as a great nation where trade associations are organized and function for the purpose of establishing sales prices. These trade associations are encouraged and fostered by the Government of that country with the idea that there will be a service done for the public in general.

In England, we have our trade associations. In the lime industry, we have, as in many of our industries, a National Federation. One reason for that in the lime industry is the multiplicity of our lime materials. We have every sort of lime material, from that producing a high-calcium, 99% lime, to a natural cement, in fact, there are far too many of them, but still they are there, and we have to deal with them. Another reason is that in England we draw a very hard distinction between chemical limes and building limes. A good architect will not permit high-calcium limes to be used for mortar purposes. We insist, in the building line, upon some degree of hydraulicity (except finishing lime), although, of course, the high-calcium lime manufacturers are always endeavoring to get a foot into the building trade as members of an association.

My own company and companies in the same association produce a lime which is known to the trade as greystone, burnt from the grey or lower chalk, which contains about 84% to 86% CaO and about 14% silica and alumina. It has definite hydraulic properties, yet has the easy-working properties of a high calcium lime. We have on the one side of us the high-calcium lime manufacturers, who produce a beautiful chemical lime which only has certain properties, we say, and is useless for building purposes, and, on the other side of us, we have the eminently hydraulic lime manufacturers, who produce a beautiful hydraulic lime which, we say, is not economical to use, is not easy to work, has low sand carrying capacity, and does not expand in bulk upon slaking.

We have a fight on either side of us, and I don't see that we could get any closer cooperation than we are getting, because there is such a vast difference between our materials.

The essential difference between our English trade associations and your own in the United States is that, with the exception of those formed especially for research, such as the Glass Association, ours exist primarily for the purpose of securing a fair price for the product by fixing a scheduled price.

Now, we do have outcries from time to time against trade trusts and trade rings, from the papers, but our experience has, I think, gone to show that not only do we protect ourselves but the consumer also is protected. In times of bad trade, and we have had plenty of them in our building industry, we stabilize the industry and prevent it from being cut to pieces, and in times of good trade, such as we are at the moment experiencing in our building industry, we protect the consumer.

That is very well shown in the brick industry, in which my greatest interest lies. Our Pressed Brick Association was formed at a time when the whole trade was being cut to ribbons, and the smaller firms were all going to the wall. Today, we have our trade association, and we have a great scarcity of bricks. My own brick company is turning back orders for millions a week, but at the same time our retailers cannot take advantage of that position, and they are not allowed to sell below our scheduled figure, but they are also not allowed to sell above. Just before I came away, two firms of retailers were taking advantage of the demand and asking for an increased price, and we immediately struck them off our list of registered merchants. I think we can claim that our trade associations do give some measure of protection to the consumers as well as to the manufacturers.

I have mentioned our building trade and its little boom at the moment. We hope we are in a period of 15 to 20 years good trade. We have just started to tackle our very serious deficiency in working-class houses.

The Government's working-class house proposition alone provides for 200,000 houses per year for at least 15 years, so that we are looking forward to a period of steady work for our building trade, which has always been either up on the heights or down in the depths. We are having to subsidize our working-class houses because, where prices are at present, it is impossible to erect working-class houses of the standard that public opinion thinks the working man should have, on an economic business basis. They are not business propositions, so we are having the state subsidize them to get the standard of house which it is felt the working man ought to have.

Our competition in the building industry, or in plasters, is from portland cement, but our portland cement seems to be easier working than American cements; in fact, there is a growing tendency today for the architect to specify straight portland cement mortars, and there is no difficulty in using them. Of course, where cost is a consideration, then straight lime mortars are employed. I hope there will be a field for hydrated lime in concrete, although I don't think it will be as great as in your country.

Our plastering conditions seem to be exactly the reverse of your own. I find you using gypsum plasters for cheapness, while with us patent plasters are used for the finishing of the best work, the rough coat being usually of grey lime. When it is a question of cost, a high-calcium lime is used for the finishing coat.

Both of these conditions, of course, mean that we only get in on the best work, or rather we only get in at all on the score of price or cost, and our mortar and finishing limes must always be kept well under that of portland cement and the patent plasters. The entire time we have to keep a margin between the price of portland cement and the price of building lime, and the same with finishing lime and patent plasters.

Hydration is just making headway for building limes. Our chemical lime producers have been hydrating for two years, and my own company has been interested for some time, but we have thought it well to go warily, because, it seems to me, that hydration must tend to level off the differences between various types of lime. The lime produced by my own company for building purposes has a very excellent reputation, I am glad to say, and although we have our competitors, we can put in our product at a little higher cost. It seems to me that in hydration there is going to be the danger that the consumer is not going to realize, or it is going to take a long time to knock it into his head, the fact that a hydrate depends upon the quality of the lime from which it is produced. To the consumer, it will be just a hydrate, and that is the danger, as I see it, although the field for cement might be of assistance to him.

The question of getting a higher CaO content in the hydrate is very interesting to me, as if we can get rid of some of our silica and alumina content by hydration, it means that my firm can tackle the chemical demand. As far as we have gone, however, the silica and alumina seem to be in too intimate association—a point we claim for our mortar lime.

Our best plants are far behind your own, or those which I have seen—a very long way behind. I am glad to say, that we are able to make up the balance on our brick plants. However, when one is entirely dependent upon such a fluctuating trade as our building trade, it requires a good deal of courage to put down large amounts of capital, in fact, it is not justified.

Your conditions have been rather different from our own in the matter of fuel. Our fuel is more expensive than yours. Your difficulty seems to be with labor, but our labor is less than yours. We therefore have to strive as hard as we can for fuel efficiency, sometimes sacrificing labor costs. Our labor stands today at a shilling, or approximately one quarter, an hour. It seems that our labor has come to realize that there is a limit to what can be taken out of industries in wages, and that it is an easy matter to kill the industrial goose that lays the wage egg. Practically all our industries make six-months' agreements with the workers' representatives, based upon the Government cost-of-living figure (which is slowly going down), and the operators are always ready to look at the manufacturers' side of the question.

The common type of kiln used in England is the direct feed shaft, with which we get very good fuel efficiency—five to one—running on coke, which, of course, differs with the kind of coke. Coke with us now is not the by-product that it was before the War, and we are having to buy coal because we simply cannot get coke. That means that we shall have to turn our attention to gas kilns. We have an excellent gas type in the Priest Kiln, which, by employing preheating and waste heat boilers, obtains a fuel ratio of six and sometimes nearly seven to one. We will undoubtedly have to turn to this type of kiln, now that the coke supply is rapidly disappearing, owing to the gas producers taking more out of it for water gas.

There is another point that I might mention, and that is with our increased labor cost, we are giving much more thought to labor-saving equipment.

Development of the Cement Business In Southern California

A Historical Sketch

By C. L. Carman
Riverside Portland Cement Co., Riverside, California

Read before the Spring Meeting of the Portland Cement Association at Los Angeles, California, May, 20, 1924.

When the writer came to Southern California in 1907, there was but one producer of portland cement in the state south of the Tehachapi Mountains, which is a generally accepted dividing line between southern California and the rest of the state. This was the plant of the California Portland Cement Co., near Colton, about five miles from Riverside, having at that time about 500 bbls. daily output. There was a current demand for a larger quantity of cement, which was met by shipments from central California and Kansas and by importations from Europe. In the construction of its Crestmore plant, the Riverside Portland Cement Co. purchased Western States cement from Carl Leonardt at a price of $3.65 per bbl. f. o. b. Riverside.

The plant of the Riverside Portland Cement Co. came into production in 1909, with an output of 2250 bbls. per day.

Some time in 1909, the City of Los Angeles, through its Aqueduct Commission, constructed a thousand-barrel plant about five miles from the town of Tehachapi, for the purpose of furnishing cement for the construction of the great Los Angeles Aqueduct.

During 1910, a small plant was put into operation at Oro Grande, Calif., about sixty miles north of Riverside, by the Golden State Portland Cement Co.

During the year 1910, the California Portland Cement Co. increased its output by building an entirely new plant of some 1600 bbls. daily capacity.

In 1911, the Riverside Portland Cement Co. increased its output to 5000 bbls. per day, and again, in 1915, it was further increased to its present capacity of 6500 bbls. per day.

In 1916, Carl Leonardt began the construction of a one-kiln, wet process plant at Victorville, Calif., about 55 miles north of Riverside. This plant was increased in 1920 by the addition of one kiln; again, in 1922, a kiln was added, and the fourth during the year 1923, so that the plant now has a daily capacity of 5000 bbls. of Victor brand cement. This plant is probably the finest example of reinforced concrete cement plant construction to be seen in this country. It is certainly the cleanest plant I have ever seen.

From time to time during the course of the last ten years, the plant of the California Portland Cement Co. at Colton has been enlarged and improved. With the new capacity put into operation during 1923, the plant has a present capacity of 10,000 bbls. of cement per day.

After the completion of the Los Angeles aqueduct, an effort was made by the City of Los Angeles to continue to operate the Monolith plant. It endeavored to sell its production, over and above that required for its own use, to other municipalities and to the public. In theory, the amount to be sold was a negligible surplus; in fact, the city entered into commercial production of cement and, fortified by taxpayers' money, went into general competition with the private companies. As a taxpayer, the Riverside Portland Cement Co. instituted and won a suit prohibiting such misuse of tax funds. The case was carried to the Supreme Court of the State, and is generally recognized as a leading case of the highest importance to the industry. In 1921, the Monolith plant was sold to the United States Potash Co., which subsequently became the present Monolith Portland Cement Co. Its output has been increased so that, when present construction is completed, the plant will have a capacity of 4000 bbls. per day.

Early in 1923, the plant of the Golden State Portland Cement Co. at Oro Grande was taken over by the Riverside Portland Cement Co. It has been entirely remodeled and enlarged to a capacity of 5000 bbls. per day.

It will be seen that the cement producing capacity in this market is over 30,000 bbls. per day; or, expressed in another way, over 11,000,000 bbls. per year, and it may be thought that such capacity to supply the wants of a population of 2,000,000 people is optimistic even for southern California. The truth of the matter is, nearly 50% of this capacity was created during the last 18 months under the stimulation of a sharp, but no doubt temporary, uptrend in building activity in this vicinity. Presumably there will be no further construction for a long period until normal growth in population has brought about a readjustment between demand and supply more in keeping with the ratio which obtains in other parts of the United States.

There are a few features of cement manufacture in southern California differing from those which generally prevail, which no doubt will be of interest to members of this Association.

The deposits of limestone suitable for cement manufacture are essentially different from those east of the Sierras in that they are isolated remnants of a metamorphic blanket once covering large areas, but which has been eroded away, leaving lenses of varying size as the only material available as a source of lime. The occurrence of these lenses accounts for the distribution of local cement plants.

Our climate is a factor in maintaining the demand for cement at a fairly uniform level throughout the year. During the rainy season, the demand may be reduced some 25% below the average for the year, and again there may be a slight falling off in the hottest months of the summer, but the flow of cement is sufficiently steady and the weather conditions for manufacturing sufficiently favorable that annual shut-downs are not indulged in. Repairs are made when required, and plants are practically never shut down for general overhauling.

The use of electric power in California cement plants and of oil for fuel, are factors which have greatly simplified the design of local plants. We have no power houses nor coal mills to build or operate, and while a theoretical economy could be effected in the cost of power, by the installation of waste heat boilers, such installations would have to include the cost of power plants, making the investment so large that the earning capacity would not be attractive on the basis of present cost of hydro-electric power. However, our dependence upon hydro-electric power has its drawbacks. California has just passed through its second winter of low rainfall. It may be said that a period of drought exists, and it is contemplated that there will not be enough power in California to supply the entire demand during 1924, and that rationing among manufacturers must take place.

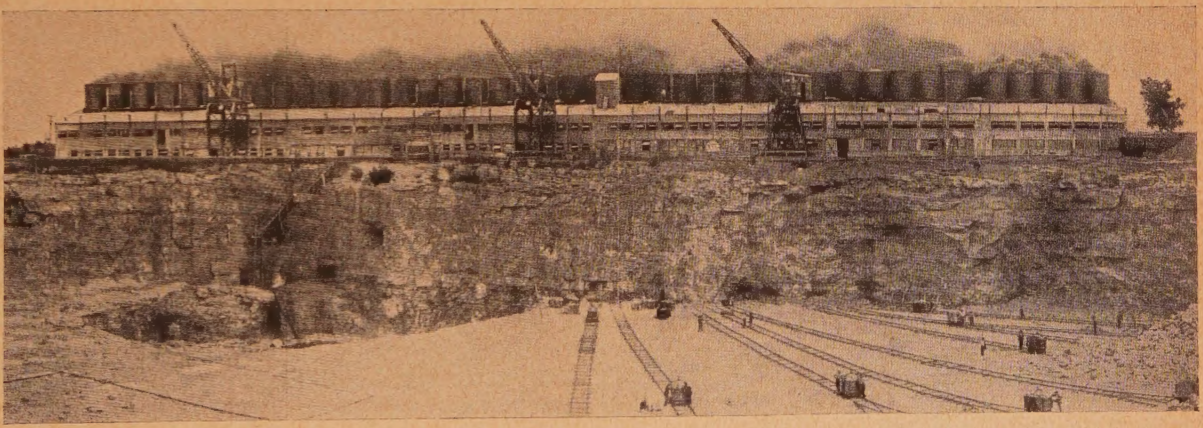


FIG. 1—PRESENT APPEARANCE OF THE UNITED STATES GYPSUM COMPANY'S LIME PLANT AT GENOA, OHIO. THE 13 KILNS AND THE GANTRY CRANE AT THE LEFT END ARE PART OF THE RECENT CONTRUCTION

Lime Plant Enlarged

To keep up with the demand for its products, the Genoa (Ohio) lime plant of the United States Gypsum Co. has been enlarged by the addition of 13 new kilns and other equipment, costing $300,000. These improvements are near completion, and early in July the entire bank of 40 kilns will be in operation, making this the largest hydrated finishing lime plant under one roof in the world. This construction, which has been in progress since last December, makes the plant's capacity 500 tons a day.

Location of the plant in the Northwestern Ohio field was determined originally by the excellent quality of rock in the Upper Niagara limestone bed. Samples from the Genoa quarry were reported by Dr. D. H. Trowbridge, of the Lewis Institute of Technology, to be "a true dolomite" limestone, its composition being 54.78% carbonate of lime, 45.07% carbonate of magnesia, .72% iron and aluminum oxides, and .26% silica. It is basically because of the high quality of the rock that the demand for the products of this plant has grown rapidly enough to necessitate enlargements.

This is the fourth such expansion. The Gypsum company purchased the property in 1915 and erected nine kilns. The next year, eight more were added; in 1919, five more; in 1923, another five; and now, thirteen more. This installation also includes a new gantry crane, a second Schaffer hydrater,[1] a second Williams' swing hammer mill,[2] a new power-house, and additional cooling, grinding, and shipping facilities.

As a result of this new equipment, the United States Gypsum Co., besides adding to its capacity for manufacturing Ivory hydrated finishing lime, adds two new products to its list: U. S. G. mason's hydrate and Grand Prize hydrated finishing lime. New packing units also have been installed, making possible the shipment of the Ivory lime in 10-lb. as well as 50-lb. paper sacks.

All these products are not only shipped direct to dealers, but also are sent to be stocked at the 22 other producing plants of the United States Gypsum Co. throughout the country. They are shipped thence, with other commodities, in straight or mixed cars. Thus, supply men can get convenient quantities of finishing lime, mason's hydrate, all varieties of gypsum wall, gauging, molding and finishing plaster, gypsum plaster board, exterior sheathing, and Sheetrock fireproof wallboard, all contained in the same car at the same freight rate they would pay if they bought 15 tons of each commodity.

Cement Production and Shipments Increase in May

The statistics shown in the following tables, issued by the Department of the Interior, and prepared under the direction of Ernest F. Burchard, of the Geological Survey, are based mainly on reports of producers of portland cement, but in part on estimates. The estimates for May, 1924, were made necessary by the lack of returns from two plants.

The month recorded increases in both production and shipments, production exceeding that of any month so far recorded in the industry and the shipments exceeding those of any month—excepting August of the preceding year. Stocks decreased by the amount of excess of shipments over production but remained at high levels.

Production, Shipments, and Stocks of Finished Portland Cement, by Months, in 1923 and 1924, in Barrels

Month	Production		Shipments		Stocks at end of month	
	1923	1924	1923	1924	1923(a)	1924
January...	7,990,000	8,788,000	a5,628,000	5,210,000	11,477,000	a14,155,000
February..	8,210,000	8,588,000	a6,090,000	5,933,000	13,596,000	a16,815,000
March....	9,880,000	10,370,000	10,326,000	8,995,000	13,045,000	a18,189,000
1st quar..	26,080,000	27,746,000	22,044,000	20,138,000	....	....
April.....	11,359,000	11,726,000	12,954,000	12,771,000	11,463,000	a17,159,000
May......	12,910,000	13,777,000	14,257,000	14,551,000	10,144,000	16,385,000
June......	12,382,000	....	13,307,000	....	9,168,000	....
2nd quar.	36,651,000	....	40,518,000	....	....	....
July......	12,620,000	....	13,712,000	....	8,081,000	....
August....	12,967,000	....	14,971,000	....	6,080,000	....
September	13,109,000	....	13,698,000	....	5,533,000	....
3rd quar.	38,696,000	....	42,381,000	....	....	....
Octover...	13,350,000	....	14,285,000	....	4,612,000	....
November.	12,603,000	....	10,251,000	....	6,991,000	....
December.	9,997,000	....	6,408,000	....	10,575,000	....
4th quar..	35,950,000	....	30,944,000	....	....	....
	137,377,000	....	135,887,000	....	....	....

(a) Revised.

Stocks of clinker, or unground cement, at the mills at the end of May, 1924, amounted to about 8,219,000 bbls., compared with 8, 545,000 bbls (revised) at the beginning of the month.

The Bureau of Foreign and Domestic Commerce, of the Department of Commerce, reports that the imports of hydraulic cement in April, 1924, amounted to 148,138 bbls., valued at $227,300. The total imports in 1923 amounted to 1,678,636 bbls., valued at $2,964,098.

The imports in April were from Belgium, 97,262 bbls.; Denmark, 23,764 bbls.; Norway, 17,765 bbls.; England, 4456 bbls.; Sweden, 2925 bbls.; other countires, 1966 bbls. The imports were received in the following districts: Los Angeles, 62,648 bbls.; Porto Rico, 26,767 bbls.; New York, 18,022 bbls.; Philadelphia, 14,798 bbls.; New Orleans, 7494 bbls.; Hawaii, 5886 bbls.; Oregon, 4927 bbls.; San Francisco, 3050 bbls.; other districts, 4546 bbls.

The exports of hydraulic cement in April, 1924, were 83,200 bbls., valued at $229,183, of which was sent to Cuba, 28,580 bbls.; to the other West Indies, 3098 bbls.; South America, 21,337 bbls.; Mexico, 19,784 bbls.; Central America, 6489 bbls.; Canada, 883 bbls.; and to other countires, 3029 bbls. The total exports in 1923 amounted to 1,001,688 bbls., valued at $2,944,174.

The statistics of imports and exports of hydraulic cement in May, 1924, are not available.

Cement Accident Rate Decreased

Both frequency and severity accident rates were decreased by cement company members of the National Safety Council, according to the 1922-23 report. This record is in marked contrast to that of most other industries, which have reported increases for the year 1923.

The severity rate for 1923 was 5.411, and for 1922, 6.504. The number of hours worked in 1923 was 76,640,596. The frequency rate for 1923 was 41.6, and for 1922, 41.7.

The Portland Cement Association's Safety Trophy for 1923 was awarded to the San Antonio Cement Co., which came through the year with almost a clean slate.

Shippers' Advisory Board Meets

At the third regular meeting of the Atlantic States Shippers' Advisory Board, held in New York, May 7 and 8, 1924, 13 representatives of cement, lime, and gypsum companies were present, and F. E. Paulson, of the Lehigh Portland Cement Co., reported for the cement committee, giving figures on the number of cars that would be needed in the district during the next 60 days.

The purpose of the Atlantic States Shippers' Advisory Board is to form a common meeting ground between shippers and railroads for the better understanding of transportation questions, to adjust, informally, car difficulties which may arise between carrier and shipper, and to give the shipping public direct advice in the activities of car service divisions on all matters of mutual concern.

Carriers and shippers are requested by the advisory board to give the proceedings the widest possible distribution among their officials and employees, with a view to enlisting their active cooperation in the undertaking. Additional copies of the proceedings will be furnished upon application to the secretary at 30 Vesey St., New York. W. J. L. Van Ham is general chairman; P. W. Moore, general secretary; L. A. Cooley, alternate general chairman; and W. B. Einstein, secretary.

---

[1] Schaffer Engineering and Equipment Co., Pittsburgh, Pa.

[2] Williams Patent Crusher and Pulverizer Co., St. Louis, Mo.

Measurement of Air Supply to Rotary Kiln

By Francis Lindstead

From a paper prepared for presentation at the International Cement Congress, London, April 22 and 23, 1924. Reprinted from the *Structural Engineer*, London.

As is the case with all furnaces a rotary kiln requires a certain amount of air for combustion of the fuel, enough air being admitted to the furnace to afford complete combustion, otherwise we get in the flue gases unburnt carbon which is wasted.

Theoretically, 1 lb. of coal requires approximately 10 lb. of air for complete combustion, but the precise amount depends upon the analysis of the coal.

But, in practice, if we only allow the theoretical amount of air per lb. of coal, we would probably get incomplete combustion, with a consequent waste of carbon in the flue gases. This is probably due to incomplete mixture of the coal and air. For efficiency, it is necessary to keep the air supply as low as possible after getting complete combustion.

The net amount of the heat absorbed by the air will be the heat required to raise the temperature of the air to that of the exit gas temperature of the kiln, and the air supplied in excess of that required for complete combustion will absorb heat, which will be wasted in the flue gases to the extent of approximately 180 B.T.U.'s per 1 lb. of coal fired for every 10% excess air, assuming an exit gas temperature of 800° F. For a kiln producing 8 tons of clinker per hour and working continuously, this would mean 5¾ tons of standard coal per week is burnt in heating every 10% excess air which passed through the kiln.

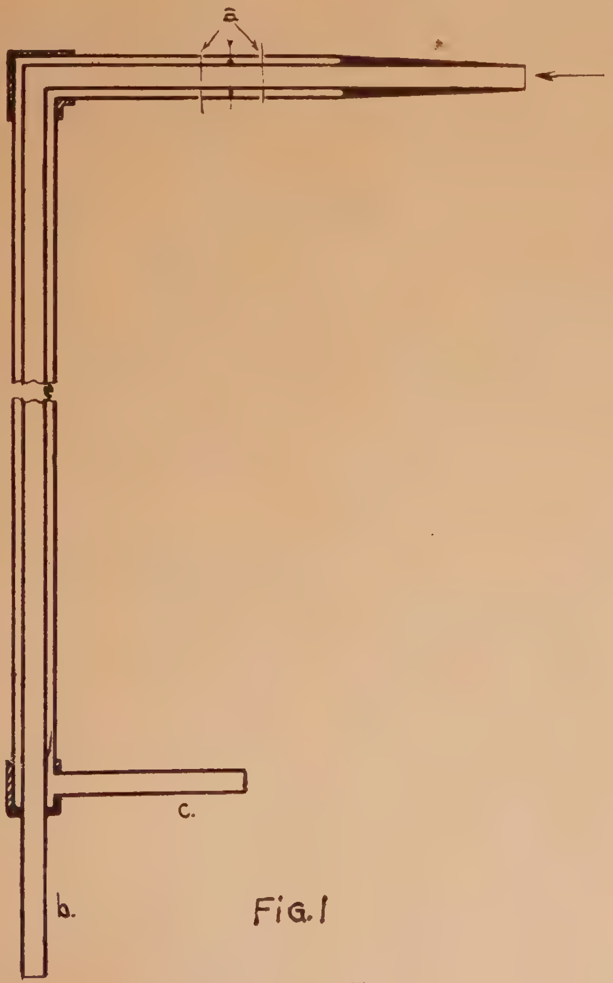
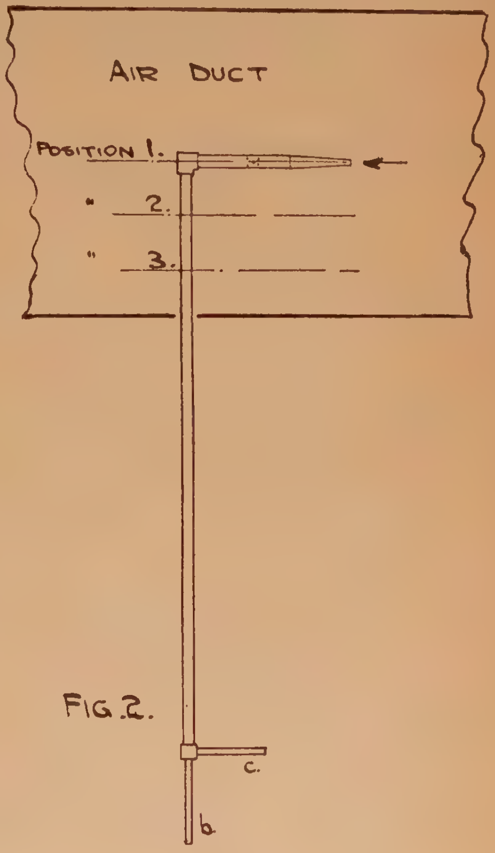


Fig. 1—Standard Form of Pitot Tube

For the proper control of the fuel consumption it is necessary to know the amount of air in the flue gases. In making a test of a rotary kiln, it is also necessary to know the amount of air passing through different ducts or pipes such as the coal firing fan pipe.

The analysis of the gases leaving the kiln is effected by the Orsat apparatus, which uses chemicals for absorbing the various constituents of the exit gases, the volume of the gases being measured before and after absorption. The sample of gas should be drawn through a pipe, the end of which should terminate well into the end of the kiln.



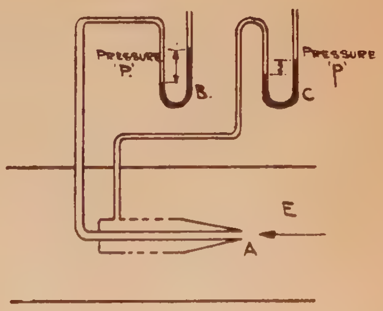


Fig. 3

Fig. 2—Position of Pitot Tube in Measuring Velocity of Air in Pipe
Fig. 3

The method of obtaining the amount of air passing through a pipe or duct, such as the coal firing pipe, is by the Pitot tube, the principle of which is that the pressure due to the velocity of a stream of air is a measure of its velocity.

If we have the cross sectional area of the pipe together with the velocity with which the air is flowing, we can get the quantity of air flowing in the pipe. The standard form of Pitot tube consists of two tubes fixed concentrically, as shown in Fig. 1. The space between the inner and outer tube is sealed at each end so that each tube is independent, the head of the tubes is tapered to an edge. In the periphery of the outer tube small holes "a" are drilled.

The instrument is placed in a current of air, as shown in Fig. 2, and the pressure due to the velocity of the air is communicated through the central tube to the water guage, or manometer, on which the pressure is registered as head of water. Since there is likely to be a static pressure in the pipe quite apart from the pressure due to the velocity, and which will also be registered on the manometer through the central tube, but which is not required.

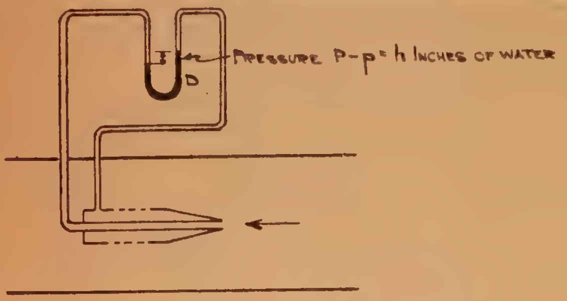


FIG. 4

Therefore the outer tube which registers the static pressure only is connected to the opposite limb of the manometer, as shown diagrammatically in Fig. 4. In this way we have the static pressure plus dynamic pressure opposed against the static pressure, with the resultant dynamic pressure registered on the manometer in inches of water.

The formula connecting the velocity of the air with the head of water is:

$$V = 174.24\sqrt{(t + 459.6)\,h} \qquad (1)$$

where V = velocity of the air in feet per min.

t = temperature of the air in the pipe in F. deg.

h = head of water registered on the manometer in inches

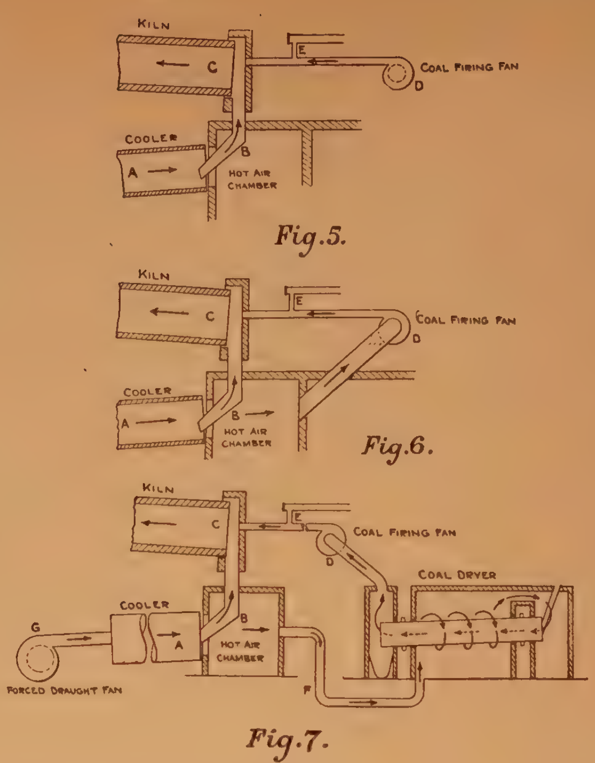
$$K_t = 174.24\sqrt{t + 459.6}$$

To save time, K_t has been put in the form of tables for every degree from 30° F. to 1000° F.

so that $V = K_t\sqrt{h}$

The velocity of air flowing through a pipe varies over the cross section, the maximum velocity being in the center of the pipe with the minimum velocity at the side, due to friction between the air and the pipe. But since we require the mean velocity, we must take the mean velocity of, say, three readings from the center to the side, as shown in Fig. 2. From experiments, it has been found that usually the mean velocity exists at a point 0.75 of the radius of the pipe from the center, so that for practical purposes, the Pitot tube placed in this position should give the mean reading.

The manometer used in conjunction with the tube should be of a type where very small differences in the height of head of water are measurable, the ordinary U-tube not being suitable.



FIGS. 5, 6 AND 7—DIAGRAMS SHOWING THE FLOW OF AIR SUPPLY TO ROTARY CEMENT KILNS

Fig. 5 shows a diagram of a kiln with an open cooler. The volume of air passing through the coal firing pipe can be measured in the manner described above with the Pitot tube. We also have a small quantity of air passing up the cooler, which can be calculated, if necessary, by difference between the quantity passing through the coal firing pipe and the quantity calculated from the gas analysis in the exit gases, or if a direct reading is necessary, by the revolving vane anemometer placed in different positions in the open end of the cooler. This instrument is of the windmill type, and its use is not to be encouraged where the velocity varies from time to time owing to the inertia of its revolving parts; constant calibration being necessary.

Fig. 6 is similar to Fig. 5, excepting that the coal firing fan is drawing a supply of hot air from the hot air chamber after being heated by the clinker in the cooler. In this case, a larger quantity of air is passing up the cooler.

Fig. 7 shows a kiln with cooler under forced draft. The coal dryer is connected to the hot air chamber by a duct through which air, after cooling, the clinker passes, and is used for drying the coal. The air as measured in the cooler forced draft fan pipe by the Pitot tube, neglecting all leakage should balance with that amount, calculated from the exit gas analysis at the end of the kiln.

In the discussion of this paper, H. J. Deane pointed out that though the author had said the ordinary U-tube was not suitable for small differential pressures, he had not indicated what form of tube should be used. The inclined tube could be used to read to 1/100 in. quite easily. He had used such tubes with a slope of 1 in 20. He was further not satisfied that the mean velocity was always at 0.75 of the radius, as the author suggested. With different velocities, he thought its position would vary.—*Engineering.*

Casing and Lubrication for Silent Chain Drives

By Paul Wheeler
Engineer, Link-Belt Co., Cleveland

In considering the installation of a new power transmission system or the replacement of an existing one, silent chain drives possess qualities that merit consideration and attention. Silent chain drives were originally designed for power transmission where neither leather belts nor meshed gears were practicable. However, they have completely outgrown this usage, and are today adopted as a most efficient transmission for all manner of service.

Under such a development, however, silent chain drives were not installed in grain elevators, flour mills, cement plants, or other places where excessively dusty or abrasive atmospheric conditions were encountered, until the universal application of these drives had been proved. The result was the slow recognition of the necessity for a dust-proof, oil-tight casing for the drives when used under such conditions. Even today the necessity for such a casing is oft-times overlooked or underestimated by users, and it has been known that transmission salesmen have failed to recommend the use of a casing when the installation was to be made in a cement plant, brick plant, or other unusually dusty place.

To the end, therefore, that a greater appreciation might be had of the casing for silent chain drives, and that increased efficiency and longevity of the installations now in operation might be developed, this article will devote itself to a discussion of casings and lubrication.

There are three underlying reasons why users of silent chain drives in cement plants should insist on proper casings for their power transmission equipment. These reasons are:

(a) To keep out dust
(b) To retain oil
(c) To increase safety

The reason why it is necessary to keep out dust is obvious. Not only is there a world of dust in and about a cement plant, but this dust is very gritty and abrasive. Much of it might be likened to a cutting compound mixed with a little oil. If this dust gets onto the chain, it proves very destructive, causing cutting into the joints, side cutting of the links, and occasionally causes the pin to protrude. This latter is thought of by the uninformed as the "lengthening of the pin."

The second reason is equally obvious, and equally important. Silent chains require lubrication. This can be accomplished in two ways—either periodic, applied with a brush, or constant oil bath in which the chain dips at all times. The latter is by far the best and is proof against neglect. If properly made of substantial material and welded corners, the dust-proof casing is oil tight as well. It is this dual combination that is most effective and efficient.

Third, and equally important with all other factors, is that of safety. Much has been said and accomplished for the principle of "safety first." Indeed, this phrase is subject to such hard work that there is danger of it becoming trite and meaningless. However, industry has not progressed to the stage where we can honestly say "Safety At Last," and thus there is a need to carry on the work of making moving parts, especially those of high speed, safe for employees. Properly cased, silent chain drives are much more safe than any other type of transmission.

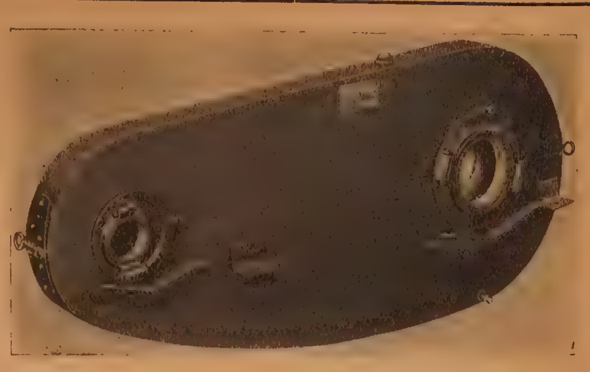


Fig. 1—Rigid Casing for Silent Chain Drive in Cement Plant Where Load is Smooth and There is Little Vibration

Need For Lubrication

There is an erroneous belief among some cement manufacturers that silent chain drives can run without oil. Just why this belief should persist is unexplainable, but it remains a fact that salesmen are frequently asked: "Can your silent chain run without oil?" Certainly it is a principle of practical mechanics that any chain drive will run better, last longer and require less attention if it operates with a proper supply of oil, in a dust-proof, oil-retaining casing, than if it operates exposed with little or no oil.

Silent chains, regardless of make, are composed of links and joints. They usually operate at high speeds. The contention that such a mechanism needs no oil or lubricant is a violation of a first principle in machinery operation. In cement plants, therefore, every silent chain drive should not only be properly lubricated but should be equipped with an oil-retaining and dust-tight casing as assurance that such lubrication would be available at all times.

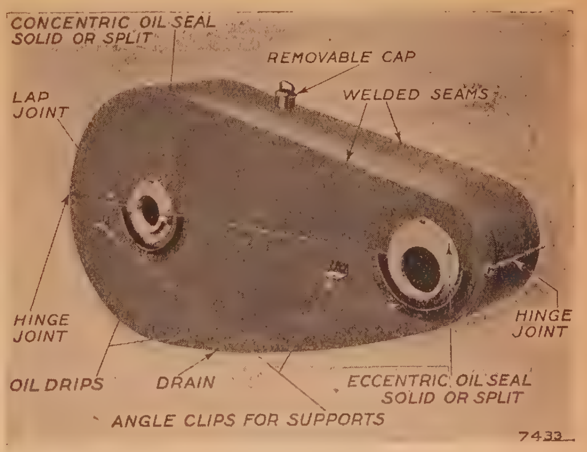


Fig. 2—Flexible Dust Proof and Oil Retaining Casing for Silent Chain Drive

Casing, for cement plants, broadly speaking, are of two types, i. e., rigid and flexible, with relation to the type of seal used at shaft openings. The former, as illustrated in Fig. 1, are used mainly on fans where the load is smooth and there is little vibration. The latter, Fig. 2, is more generally used, it being more applicable to drives where there is noticeable vibration. In either case, these casings are equipped with

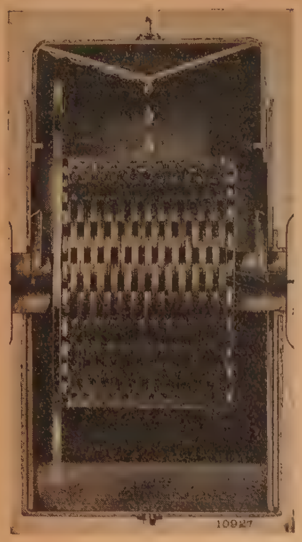


FIG. 3 — SECTIONAL VIEW SHOWING USE OF DISC OR SLING TYPE OF LUBRICATION OF CHAIN DRIVE

an eccentric oil seal on the motor, or driving end. This permits of adjustment or motor take-up, without interfering with casing supports, or losing its sealing feature around the shafts. These casings are of substantial material (about 12 gauge, hot rolled steel, with welded corners). And it requires a rugged job of this kind to successfully withstand the vibration and rough usage, and to prevent bulging and warping. There should be a greater militancy on the part of cement manufacturers for ruggedly built casings—not allowing a local tinsmith or blacksmith to care for the job, as such instances invariably make for slipshod casings—for poor casings have actually ruined an otherwise sound, silent chain drive application.

Lubrication is of two types: the usual bath or splash type (wherein the driven wheel and chain is slightly submerged in oil), and the disc or sling type. The former is usually used, but in the event the motor shaft is much lower in relation to the driven shaft, and in which case the oil will pocket in relation to the driven end of the casing, the disc type, as shown in Fig. 3, is used.

It will be noted the disc automatically dips into the oil reservoir, throwing it against a V-splash plate on top, whence the oil drips down onto the chain, providing a constant, uniform lubrication.

The majority of the cement mills throughout the United States are silent chain equipped, on ball mills, fans, clinker crushers, pumps, screw conveyors, etc. Recognition has come strictly on merit, but such recognition will be all the more definite and well defined if the users or prospective users of silent chain will properly case and lubricate their installations, thus enabling that type of power transmission to give the maximum in service with the minimum in required attention, expense, and so forth.

Special Anti-Dumping Duties Sought on Imported Cement

Cement from the Scandinavian countries and Belgium is being dumped on the American market at prices below the home market value, domestic manufacturers declared at a hearing, June 6, before Assistant Secretary of the Treasury Moss, in charge of customs. Evidence produced by the manufacturers also purported to show that the prices at which the imported cement is being sold are lower than the domestic cost of production. Application of special duties under the Anti-Dumping Act was sought.

Importers of the foreign cement contended that total imports of cement into the United States are negligible as compared to the huge domestic production. The domestic manufacturers parried this argument by asserting that because of its peculiar characteristics, the market for cement is limited to a comparatively small area adjacent to the manufacturing plant or the port of entry, and consequently, they declared, domestic plants near these ports have been seriously injured by importations.

The greatest damage to domestic business apparently has been along the Pacific coast and in the southeastern part of the country, but importers denied that the business of manufacturers in these sections was affected to an extent sufficient to warrant invoking the Anti-Dumping Act, and opposed issuance of an order declaring that cement from Norway, Sweden, Denmark, and Belgium was being dumped on the American market. The domestic manufacturers were represented by Jesse P. Crawford, of Washington, D. C., and Joseph N. Teal, of Oregon. The spokesmen for the importers were Joseph Casey, of San Francisco, and George Puckafer, attorney for Norwegian manufacturers.

An investigation by the Treasury Department has disclosed that Norwegian cement has been sold in the United States at prices lower than the home market value, H. A. Hayward of the Customs Division stated at the hearing. Swedish and German manufacturers refused to disclose information regarding their costs and prices, and difficulty was also encountered in obtaining comparative figures for home market value and export prices in Denmark, he said.

It is doubtful whether British manufacturers have made any sales in the United States below the market value in Great Britain, according to Mr. Hayward, and Belgian export prices have been higher in general than the prices in the domestic market in that country, the Treasury Department's investigation indicated, he said.

Canadian Cement Prices Drop

A reduction of portland cement prices in the Toronto and Montreal districts amounting to about 15% has been announced as effective on Monday, June 9, when the manufacturers revised their prices to the dealers, who, in turn, passed the reduction to the contractors.

According to *Contract Record and Engineering Review*, only the car lot price is affected for the present. The price applying to small quantities remaining unchanged. The drop in the Toronto district was 38¢ per bbl., bringing the car lot price, including bags and sales tax, f. o. b. siding to $3.12, as against the old price of $3.50. This new price is also subject to a 10¢ per bbl. discount for payment within 20 days from date of shipment, making the net price $2.10 instead of $2.48, after deducting 20¢ each for sacks and the sales tax.

It is announced that of the 38¢ per bbl. reduction, the manufacturers are revising their price to dealers to the extent of only 35¢ per bbl., and the dealers are reducing their margin of profit by 3¢.

In Montreal, the price in car lots f. o. b. sidings is given as $3.07 per bbl. less discount 10¢ and less 80¢ per bbl. for sacks.

Cement Association Meeting Draws Large Attendance

For the first time in five years, the Portland Cement Association met on the Pacific Coast, Los Angeles being the meeting place for the spring meeting this year. In 1919, the spring meeting was held in San Francisco. This year the sessions were held at the Los Angeles Biltmore, May 19 to 21, inclusive. Forty-eight member companies were represented by about 140 registrants.

As usual, the sessions were given over to discussions of technical subjects of interest to cement manufacturers, committee meetings, and the general business session.

Meetings of standing committees occupied most of the opening day. At the mill session, on Tuesday, May 20, papers were read by C. L. Carman, of the Riverside Portland Cement Co., and by J. P. MacKenzie, of the General Electric Co. Mr. Carman's paper was entitled "Historical Sketch of the Development of Cement Plants in Southern California," while Mr. MacKenzie discussed "Synchronous Motors for Cement Mill Drive." These papers are presented practically in full elsewhere in this issue.

At the business session, on Wednesday, May 21, the first annual award of the Portland Cement Association's prize trophy was made. This trophy was won by the San Antonio Portland Cement Co., whose record for 1923 showed it had outdistanced a large number of other member company plants toward the goal for safety in mill operation. A most amazing record of the industry in accident reduction for 1923 was reviewed briefly by John Treanor of the Riverside Portland Cement Co., who is also a member of the Association's Committee on Accident Prevention and Insurance, and who presented the trophy to S. F. Barrera, who was in attendance at the meeting as a representative of the San Antonio Portland Cement Co. Mr. Treanor called attention to the fact that Government statistics show that for the country over, industrial accidents are, in general, on the increase, while for the cement industry as an individual exception, the records show a progressive decline in serious accidents, and in time-lost accidents in general.

The formal dinner of the Association concluded the three-days' session on the evening of May 21, and was the scene of good fellowship and merrymaking, due to the novel and entertaining program provided by the Los Angeles Entertainment Committee, consisting of F. H. Powell, Norman Macbeth, and Wilmar Evans.

An Unchanging Fineness Sample

Evidence has been obtained by the Bureau from time to time that portland cement increases in fineness with age. It is probable that the rate of increase is not the same for all cements, but varies in accordance with the method of manufacture, such as burning of clinker, etc. The Bureau has kept portions of all standard cement fineness samples which it has prepared, and it believes that if these were tested with its standard sieves, they would all show an increase in fineness. There is, therefore, no absolute (unchanged) standard of fineness to check against, since dependence must be placed on the constancy of sieve corrections and the accuracy of operators. An absolute (unchanging) standard is desirable, and the Bureau believes that a suitable material is on hand for preparing such a standard. This is a very fine sand, uniform in size gradation, and being almost pure silica, there is no reason to believe that it would break up or disintegrate with age if kept in sealed containers.

Further work in connection with this material will be carried out.

Demand for Canadian Lime Decreasing

The lime industry is carrying on under marked difficulties in Eastern Canada this year. In the first place, the demand is much lighter than expected. This is reported to be due to a collapse of the building boom in New England and the eastern and central states. To complicate this situation, there has been an even more significant collapse in construction in Canada. Despite the slump in building, there is a limited demand for Canadian lime from the United States as well as in the home market. However, freight rates on the railroads have been considered too high. This has caused most of the lime to be shipped by schooner, particularly when exported. The rates by water were low for a time, but they have increased, owing to a comparative scarcity of bottoms, which is attributed to the presence of so many Canadian schooners in the liquor smuggling traffic between Canada, West Indies, Miquelon, and Newfoundland on one side, and the United States on the other side. Some of the shippers are preferring to hold the lime rather than chance sales in the U. S. and pay heavier schooner charges than anticipated. The lime manufacturing industry has also been penalized through the burden of taxation placed on it in some of the provinces by compensation boards. This is particularly true in the province of New Brunswick, where the government has refused relief.

Lime manufacturers in the province of New Brunswick, who were hoping for a reduction in workmen's compensation taxation, are apparently doomed to disappointment. The provincial government has refused the requests made for the reduction from unlimited liability to $3500, and for the abolition of medical treatment. It was proved that members of the medical fraternity were profiting hugely by retaining injured persons on the compensation rolls. Had these requests been granted, the compensation rates would have been substantially decreased.

Approximately 60% of the lime manufacturing plants in Eastern Canada are operating at present. All of the larger plants are busy, but the smaller plants have been idle for some weeks. As indications are that present conditions will continue through the summer and fall, it is hardly likely that the plants will resume operation this year. Among the larger concerns that are operating their plants are: Bathurst Co., New Brunswick Lime Co., Clairmont Lime Co., Randolph & Baker, Fraser Companies, Miramichi Lumber Co., Dalhousie Lumber Co., Stetson & Cutler, Charles Miller & Sons, Murray & Gregory, J. K. Pinder, Douglass & Co., J. B. Snowball & Co. and Harquail & Co. Operations planned for a number of new lime manufacturing companies have been deferred until early in the fall.

Atlas Lumnite Cement Co.

The name of the former Atlas Aluminate Cement Co. has been changed to the Atlas Lumnite Cement Co. The Atlas Lumnite Cement Co. is the first company to manufacture high alumina cement on a commercial basis in the United States, and is now in a position to manufacture the new product to meet construction requirements.

Men and Mills

Notes from the Field

A fire broke out in the wooden tunnels underneath the storage bins at the Michigan State cement plant at Chelsea, June 2. Through the efforts of the Ann Arbor and Jackson fire departments, the fire was confined to the one packing and storage bin house. This building, together with 9000 bbls. of cement and two packing machines that were damaged by the fire, were fully covered by insurance.

Temporary packing machines have been shipped from Chicago, and loading cement is continued at the rate of ten cars per day. Contracts have been let for a new steel storage warehouse and packing house.

The Southwestern Portland Cement Co. is proceeding with the construction of its new cement plant at Osborn, Ohio, as rapidly as the weather permits. This plant will have a maximum capacity of 6000 bbls., and an initial daily capacity of 4500 bbls. It is expected by company officials to have the plant in operation for at least a part of next year's business.

The Macdonald Engineering Co. has a contract from the Sandusky Cement Co., of Cleveland, Ohio, for a stockhouse at that company's York, Pa., plant. This stockhouse consists of four bins 27 ft. in diameter by 80 ft. high, with interspace and side pocket bins. This building will rest on a rock foundation.

S. H. Bates, foreign manager for the Bates Valve Bag Co., Chicago, is at present spending a few months in Europe, having visited England, Norway, Sweden, and Denmark. Upon his return, he expects to visit France, Belgium, Switzerland, Italy, and Spain, visiting cement plants in those countries.

The Louisville Cement Co. has adopted crawlers for its No. 1 shovel, A. Maloney, of the erecting department, Marion Steam Shovel Works, having recently spent several days at the Louisville plant supervising the work of equipping the shovel with crawlers.

No new developments are reported in regard to the bankrupt Choctaw Portland Cement Co. There are quite a number of matters pending, but no definite conclusion has been reached as to the final disposal of the company.

Bellingham cement is in great demand in Washington, according to reports from that state. The entire product of the Olympic Portland Cement Co. is being sold in the state, the shipments approximating 50,000 bbls. a month. The plant is running three shifts of eight hours each. In addition, crews are employed at Balfour in the quarries, and in the clay pits of Brennan.

The Macdonald Engineering Co., of Chicago, is building three raw mix bins at Cape Girardeau, Mo., for the Marquette Cement Mfg. Co. These are 30 ft. diameter by 35 ft. high, and have open basement below and monitor above. The large stockhouse and packing plant that the Macdonald company is building at Cape Girardeau is nearly completed.

On June 9, the Newaygo Portland Cement Co. billed out 7000 bbls, or 28,000 sacks of cement. Business is good and orders are coming in first rate shape, according to recent reports.

Word from Denver says Denver chapter of the Izaac Walton league has been organized, with Charles Boettcher and Harry C. James of the Cement Securities Co. as charter members. These gentlemen have always agreed on their company's policies, but just wait until they discuss as to who caught the biggest fish.

The Denver Chamber of Commerce advises that cement, mill boards and pipe covering, in mixed carloads, will shortly be reduced 5¢ per 100 lb. between Chicago and Denver. This is the result of a long-drawn-out fight between the railroads and the Chamber.

Harry Miller, for some years a lime manufacturer, died suddenly in St. John, N. B., recently. The late Mr. Miller had been identified with the firm of Charles Miller & Son, which was founded by his father.

All cement plants in Alabama are operating at maximum capacity, with orders ahead to insure this basis of production for some time to come, according to a recent report. The Lehigh Portland Cement Co. is setting up its fourth kiln and units at the new works in the vicinity of Birmingham, and plans to place the extension in operation at the earliest possible date. The Atlas Portland Cement Co. is active in its Leeds works, near Birmingham, and will soon complete a new bag factory there. Each of these mills has a rated output of close to 1,500,000 bbls. per annum.

For the first time since it was opened, the Birmingham branch plant of the Lehigh Portland Cement Co. recently competed in the national safety campaign that is put on annually by the head offices of the company, according to reports from Alabama.

The general plan of the campaign is to award a trophy to the plant that can operate during the entire month of June without an accident serious enough to cause loss of time of any employe.

The Donner Steel Co., Buffalo, N. Y., has recently received contract for 400 tons of concrete reinforcing bars, to be used in the new cement plant of the Southwestern Portland Cement Co., at Dayton, Ohio, and a similar contract for a new addition to the Peerless Portland Cement Co.'s plant at Detroit.

The Giant Portland Cement Co. declared a dividend of 3½% on the preferred stock, payable June 16, to record May 31. This leaves slightly over 30% unpaid dividends on the issue.

A large party of officials and agents of the Pacific Portland Cement Co. visited the plant at Cement, Calif., recently on an inspection trip. The company's new gypsum plant at Gerlach, Nev., has just been opened, and has a production of 500 tons of plaster daily.

More than 40 members of the Builders' and Traders' Exchange of Grand Rapids visited the Newaygo Portland Co.'s plant at Newaygo, Mich., recently on an inspection trip. Harry P. Willwerth, secretary of the exchange, and Joseph F. Lockley, of the cement plant, were in charge of the inspection.

The Norfolk, Va., plant of the Giant Portland Cement Co. has recently been acquired by the International Cement Corp. of New York City. H. H. Muehlk, treasurer, is credited with the statement that the International intends to rebuild the plant to a million-barrel-a-year capacity with three kilns, and add to its chain of national and foreign mills.

The Ford Motor Co. has recently acquired 2685 acres of rich limestone land with a mile of Bay Shore frontage on Thunder Bay, near Alpena, Mich. The shore property, which serves as an outlet to the stone lands, is located on the eastern shore of Whitefish Bay, a small recess of Thunder Bay just east of the old Alpena cement plant.

The experimental kilns of the Western Lime & Cement Co., Milwaukee, Wis., have been satisfactorily operating since production was begun, and, so far, burning has been confined to coal and gas, no wood having yet been tried out.

The plant is running at full capacity, with most of the lime going into the paper mill trade in the vicinity. An expansion program for the plant is already being planned.

The Macdonald Engineering Co. is constructing a clay storage building for the Northwestern Portland Cement Co., at Mason City, Ia. It consists of retaining walls 22 ft. high, the outside of the walls being 75 ft. wide x 200 ft. long. The company has also just completed a large stockhouse at this plant, having an approximate storage capacity of 288,000 bbls. of cement.

Warren Breinig, Stockertown, Pa., has been promoted to assistant superintendent of the Hercules Corporation's plant.

The Lawrence Portland Cement Co. of Northampton has purchased the large farm of Samuel Achenbach, near the Bath Portland Cement plant at Jacksonville, for $25,000, according to a report from that district.

Western Trunk Line Tariff Suspended

The Interstate Commerce Commission has suspended operation of railway tariff schedules proposing to restrict the routing in connection with carload commodity rates on cement from various Western Trunk Line producing points, such as Oglesby, Ill., Mason City, Ia., and Iola, Kans., to Fordson, Minn., so that such rates would not apply via the Chicago & North Western, Chicago, Burlington & Quincy, Chicago Great Western, Chicago Rock Island & Pacific, Chicago, St. Paul, Minneapolis & Omaha, Minneapolis & St. Louis, or Minneapolis, St. Paul & Sault Ste Marie, which would result in the application of higher combination rates via the restricted routes.

The present through rates to Fordson from Oglesby and Iola are 16 and 19½¢ per 100 lb., respectively, and the proposed St. Paul combinations 23½ and 27¢. The schedules were published in Supplement No. 28 to Agent E. B. Boyd's tariff I. C. C. No. A-1343 to become effective June 20, and their operation was suspended by the Interstate Commerce Commission until October 18, pending investigation as to the reasonableness of the application of the higher combination rates.

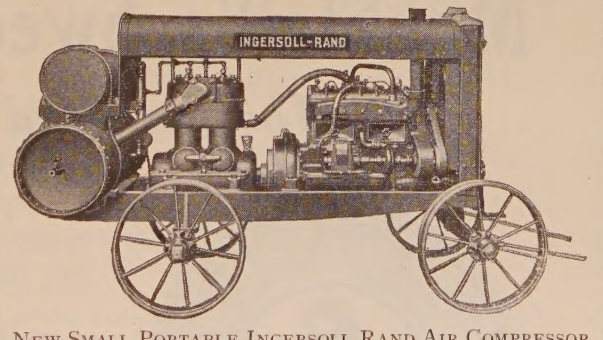
Reduction in Freight Suspended

A sharp reduction proposed in the carload freight rates on cement from Dixon and La Salle, Ill., and Hannibal, Mo., mills to stations in Kentucky on the Louisville, Henderson & St. Louis Ry. has been suspended by the Interstate Commerce Commission until October 3. The proposed schedules were published in Supplement No. 1 to Agent B. T. Jones' tariff I. C. C. No. 1517, to become effective June 5, and contemplated revision of the rates between the points named on the combination basis, resulting in reductions ranging from ½¢ to 5¢ per 100 lb. The following statement of rates to Owensboro, Ky., is illustrative of the effect of the proposal. The present rates to Owensboro from Dixon, Hannibal and La Salle, respectively, are 20.5, 20 and 19.5¢ per 100 lb., and the proposed rate in each instance 15.5¢.

Small Portable Air Compressor

A small portable air compressor plant of modern design and construction, has been developed and is now being offered by the Ingersoll-Rand Co., 11 Broadway, New York.

This small portable air compressor, designated as the 4¼ in. x 4 in. Type Twenty, has a piston displacement of 60 cu. ft. per min., and is built along the same lines as the larger Type Twenty portables. All of the proven features of the larger units are retained, e. g., duplex, vertical compressor, direct-connected to a four-cylinder, four-cycle, tractor type gasoline engine; enclosed construction; circulating water cooling system for engine and compressor with sectionalized-radiator, fan, and pump; compressor regulator and engine control for reducing speed during unloaded periods; one-piece cast steel frame; sheet steel roof and removable side doors.



New Small Portable Ingersoll Rand Air Compressor

The 4¼ in. x 4 in. Type Twenty portable opens up a new field. Its moderate cost, the manufacturers state, makes it possible and decidedly profitable to use labor-aiding compressed air equipment for work which was formerly considered too small to warrant the purchase of a compressor. It will supply necessary air for operating a paving breaker, jackhamer rock drill, riveting hammer, or other air tools, for road and paving repairs, for digging pipe trenches, for calking pipe, etc. A portable compressor can be moved from one job to another, and can be used in places where air lines are not installed and would be too expensive to put in for temporary work. This compressor can be furnished with a variety of mountings. This and other sizes of Type Twenty portable compressors are available with either gasoline engine or electric motor drive.

Trade Publications

The Economy of Better Lubrication. This recent publication of the McCord Radiator & Mfg. Co., Detroit, Mich., containing illustrations of their Class B lubricator adapted to small steam engines, oil engines, gasoline engines, air compressors, steam pumps and auxiliaries, points out the phases of economy that can be obtained from proper and efficient lubrication. The outstanding features of economy due to this type of machine, its importance and necessity are all clearly enumerated and described. The booklet contains a complete set of overall dimensions, price lists, and description of the lubricator.

Lubrication of Heavy Construction Equipment. The McCord Radiator & Mfg. Co., Detroit, Mich., has just had issued a booklet describing the part lubrication plays in the dependable operation of heavy machinery, such as steam shovels, cranes, dredges, hoisting engines, and coal- and ore-handling apparatus. This booklet points out that the continuity of service, reduced maintenance costs, and satisfactory operation of equipment are due to efficient lubrication. The publication is known as the Class BA Catalog, and contains a very detailed description of the Class BA Force Feed Lubricator, with illustrations and price lists.

In a 36-page, two-color publication, 8½ in. x 11 in., entitled *Westinghouse Fittings for Pipe Structures*, the Westinghouse Electric & Manufacturing Co. has recently announced a new and complete line of interchangeable pipe fittings for structural work. The publication, which is known as Circular 1676, desrcibes these fittings and gives their application to such work as the erection of outdoor sub-stations, switching equipment, switchboard frames, racks, railings, fences, etc. It contains a large number of photographic illustrations, supplemented by dimensional drawings, making the publication useful as a reference book for the designer of such structural work.

An adjustable insert for fastening machinery or other equipment to concrete floors, walls or ceilings is also described and pictured in the publication.

The Spencer Construction Company is the title of a 32-page booklet, 5½ x 8½ in., issued by the Spencer Construction Co., Baltimore, Md., describing Spencer-built structures including cement storage bins of monolithic construction, built by Spencer moving-form methods. Among the cement storage plants illustrated are those of the Lehigh Portland Cement Co., at Birmingham, Ala., Pittsburgh Plate Glass Co., Zanesville, Ohio, and National Cement Co., Montreal, Que.

Believing that enough thermo-electric pyrometers are in use to warrant a special publication on their installation and care, The Brown Instrument Co., of Philadelphia, has recently published a 72-page book covering this subject thoroughly. It is entitled *Instructions for Installation and Care of Thermo-Electric Pyrometers.* There is hardly a man who works with pyrometers who does not at some time desire information regarding protecting tubes for thermocouples, and various methods of wiring indicators and recorders, methods of eliminating cold junction errors, methods of installing couples, and of checking thermocouples, wiring, or the accuracy of the instruments. These subjects are gone into from the practical and theoretical angles, as well as such other subjects as open and conduit wiring, mounting the instruments, locating defects in the thermo-electric circuit by various means, and many other points which will be of immense interest to the man who has to work with the equipment from day to day. This book also contains temperature Milli-volt Equivalents for thermocouples and conversion of Fahrenheit and Centigrade scales. It is free to users of pyrometers.

Crane Track Wheels is the name of a 12-page booklet issued by the Stroh Steel Hardening Process Co., Pittsburgh, Pa., describing the hammered Stroh steel wheels for cranes. The folder, 6 in. x 9 in., with illustrations, is put out to introduce commercially the results of the Stroh efforts and, in another sense, as a protest against the needless variety of sizes and contours of crane track wheels.

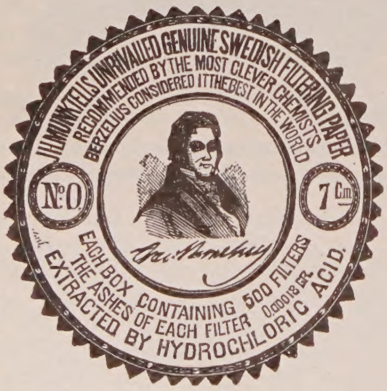
The diameters and contours of the Stroh wheels were selected as the concensus of opinion after comparing several hundred working drawings now in use and analyzing the constructive criticism of the chief engineers of many of the large crane builders. A table of dimensions of standard crane track wheels is included.

A folder, under the heading "The Stroh Process and Cement Mill Machinery," describes the Stroh process as a method of casting the highest grade alloy steel together with ordinary soft steel in one solid casting. The use of Stroh steel for gears and pinions and for slugger rolls is described and illustrated.

WANTED—One Cement Kiln, 8 ft. x 80 ft., new or second hand, in good condition. The Krebs Pigment & Chemical Co., Newport, Del.

Munktell's Swedish Filter Paper

The Standard for Comparison


J.H. MUNKTELL'S UNRIVALLED GENUINE SWEDISH FILTERING PAPER
RECOMMENDED BY THE MOST CLEVER CHEMISTS
BERZELIUS CONSIDERED IT THE BEST IN THE WORLD
No. 0.
7 Cm
EACH BOX CONTAINING 500 FILTERS
THE ASHES OF EACH FILTER 0,00018 GR.
and EXTRACTED BY HYDROCHLORIC ACID.
Jac. Berzelius

The above trade marked label is found in nearly all laboratories where fine filter papers are used.

It is not necessary, therefore, to introduce it further.

Our stock is constantly moving, and shipments are continually arriving. This insures fresh stock at all times, and prompt delivery in spite of the difficulty of keeping up with the ever increasing demand.

Write for circulars, samples and prices.

Since 1852 **E. H. Sargent & Co.** Laboratory Supplies
155-165 East Superior Street, CHICAGO, ILL.